Experiences with Teaching Basic Statistics in an Introduction to Civil Engineering Class

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Abstract - *Following a widespread national trend, in 1996, a new two-credit hour course titled "Introduction to Civil Engineering" was introduced at SIUC. The class has a one-hour lecture per week, and a two-hour lab or small group session. One reason for the introduction of this class was to provide earlier contact with the students in the CE major in an effort to reduce the number of students who change their major before they take a civil engineering class. Additional reasons for the introduction of this class were to provide training in the use of computer programs that the students will use in subsequent classes, and to provide a design experience early in the student's program of study, thereby, helping to integrate the engineering design experience throughout the curriculum. The final reason for this class is to introduce students to some basic concepts of statistics. These last three reasons are based on ABET suggestions to integrate design, computer usage, and statistics throughout the civil engineering curriculum.*

The topics of the lectures include the following: A discussion of the profession of engineering; sub-fields of civil engineering (i.e., structures, environmental, etc.); engineering ethics and professionalism; the engineering design process; written and oral communication skills; and introduction to statistics. This paper will focus on the experiences of the author with the last topic: Introduction to Statistics.

Very basic statistical concepts were covered. About 6 class hours were devoted to the subject. Professional prepared instructional videotapes were used. Some homework was assigned. The topics covered included measures of center (mode, mean, median), histograms, normal distributions, standardized curves, and linear regression. Student performance was measured by the homework grades, and student attitudes and opinions were measured by a questionnaire prepared by the author.

The results are interesting. As might be expected, students found the topic to be of little interest. Student performance depended on their math backgrounds. The students were taking Math classes such as College Algebra, Trigonometry, and Calculus. As is expected, students in the higher level classes performed better. The material covered did not require the knowledge or use of Calculus, however.

The conclusions of this work are that it is difficult to get engineering students to be interested in statistics, especially at the freshman level. One major difficulty with teaching this topic in a freshman class is the disparate math skills. The typical first semester engineering student is often not taking Calculus I as they did in the past. The implications of this fact are far ranging. The traditional eight-semester curriculum is predicated on taking Calculus very early in the program. If many students are not taking Calculus I till the second or third semester of their academic careers; the structure of freshman-level introductory courses needs to be carefully considered.

INTRODUCTION

Recently, a set of first year level "Introduction to Engineering" courses have been added to the curriculum at Southern Illinois University at Carbondale (SIUC). This paper is concerned with the Civil Engineering course "CE 101 - Introduction to Civil Engineering." There were many reasons for introducing this course. Some of these reasons were in response to the Accreditation Board for Engineering and Technology (ABET) guidelines about integrating design, computer usage and statistics throughout the curriculum. Recent statement of the ABET 2000 requirements state "Graduates of the program must have demonstrated… proficiency in mathematics through differential equations, probability and statistics…" By introducing students to these topics at the freshman level, a foundation is created. While it is not expected that the students become experts during this class, they should have a basic appreciation of statistics that will be expanded on in subsequent laboratory classes, and in upper level design classes.

This paper will discuss the author's experiences teaching this class for the last two semesters. Some details on the mechanics of this class, as well as the students' reaction to the efforts were discussed in Reference [1].

STATISTICAL TOPICS COVERED

To help integrate the knowledge and use of statistics throughout the civil engineering curriculum, it was decided to include some discussion of statistics in this introductory class. Currently, no formal class in statistics is required in the Civil Engineering curriculum.

A set of three videotapes called "Decisions Through Data" by David Moore [2] were used as the basis of the instruction in statistics. There are five tapes in the series but only the first three were used. These tapes are aimed at upper level high school students, so they were deemed appropriate for first year engineering students. These tapes illustrate the basic principles and show some real world applications of statistics.

The topics covered in these three tapes are broken up into units. The 14 units covered were:

1. What is Statistics?
2. Stemplots
3. Histograms and Distributions
4. Measures of Center: mean and Median
5. Five-Number Summary and Boxplots
6. The Standard Deviation
7. Normal Curves
8. Normal Calculations
9. Standard Deviations
10. Exponential Growth
11. Scatterplots
12. Fitting Lines to Data
13. Correlation
14. Case Study: Save the Bay

As can be seen, the topics include very basic statistical concepts. To gage the effectiveness of the instructions, homework assignments were given. To measure the student reaction to the topic of statistics, a brief questionnaire was prepared. The results are discussed in the next sections.

STUDENT BACKGROUNDS

There were about 30 students enrolled in the class, and 27 responded to the survey. One item of interest was the math background of the students taking the class. Four questions were posed to measure the backgrounds of the student. The first item asked the student how many math classes they had taken in their high school studies. These results are presented in Figure1. As can be seen, most students had taken three or four years of high school math.

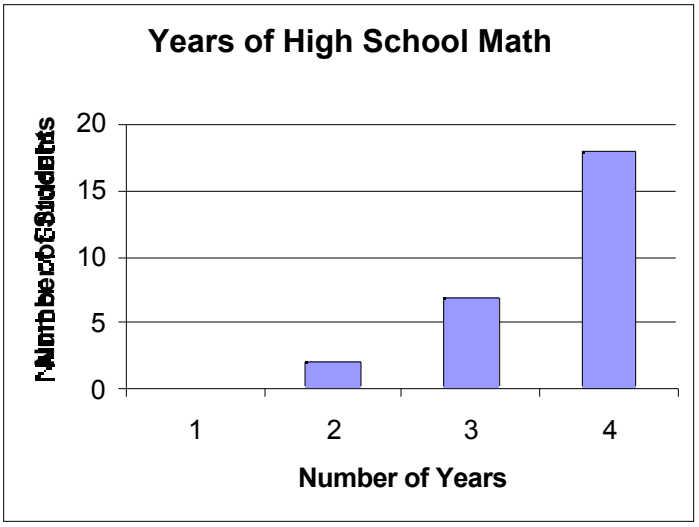

Figure 1. Math Experience in High School

The next question asked the students how they had done in those math classes. These results are presented in Figure 2. Most Students reported that they were "A" or "B" students in math. The final question about their pre-college math background asked what their Mathematics score was on the ACT test. These results are presented in Figure 3. There were a few very high scores, a few very low scores, and most responses were in the mid-twenties. From these results one can conclude that the students math preparation was typical for freshman engineering students at an institution with admission requirements similar to those at SIUC.

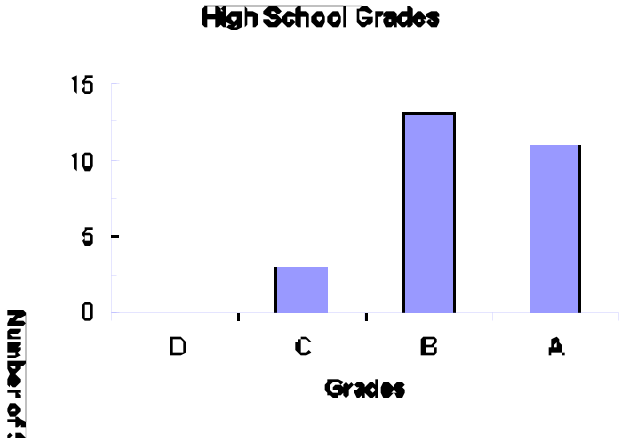

Figure 2. Student Success in High School Math.

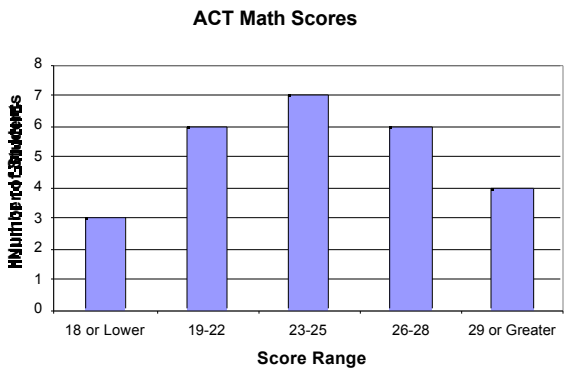

Figure 3. Student ACT Math Scores.

Another question asked the students what math class that they were currently taking. These results are presented in Figure 4. Of the 27 students only nine or 33% were taking Calculus. Another nine were taking Algebra. The remaining students were taking Trigonometry, except for the two students who were not taking any math class. These results are similar to the results from previous semesters. Expected grades are presented in Figure 5.

It is an eye-opening fact that less than one-half of the first semester engineering students are taking calculus.

The current eight semester curriculum for engineering is based in large part on the assumption that students take calculus their first semester. The chain of pre-requisite classes run through four or five math classes, physics,

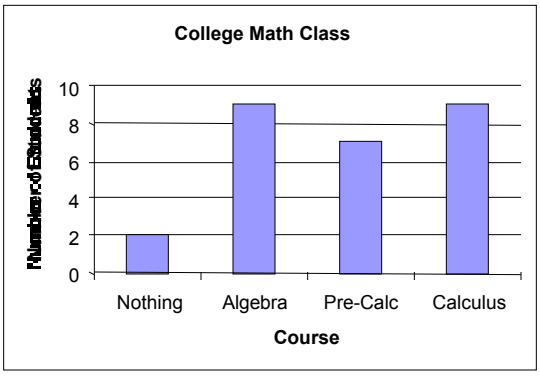

Figure 4. Math Class that Students Are Currently Taking

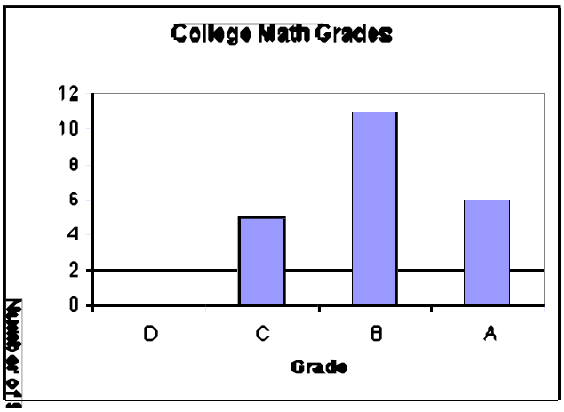

Figure 5. Student success in college math classes.

statistics, and many other engineering science and design classes. Those students who take trigonometry during their first semester may be able to complete the degree in

eight semesters. Students who take algebra in their first semester probably need to take a second math class before calculus and will definitely need more than eight semesters to complete the degree.

STUDENT REACTIONS

There were about 30 students enrolled in the class. The average scores on the two homework assignments were 64 and 72. These numbers are about typical for grades on exams or homework in any engineering class, so the tapes and the course of instruction appear effective.

The students' reactions to statistics were also obtained. While it is difficult to draw general conclusions based on the responses of the 27 students who filled out the questionnaire, some general statements can be made.

Students were asked to rate the difficulty of the statistics concepts covered on a scale of 1 to 10 with one being the easiest. The average rating was 6.15. This included three scores of 1 or 2, all reported by students who said that they had covered the material previously. Six students rated the difficulty as 8 or 9 including one student who said that he had covered the material before. These results are presented in Figure 6.

Students were asked to rate the how interesting the coverage of the statistics concepts was on a scale of 1 to 10 with one being the very boring. The average rating was 4.5. This included six scores of 1 or 2. Only six students rated their interest over 5. These results are also presented in Figure 6.

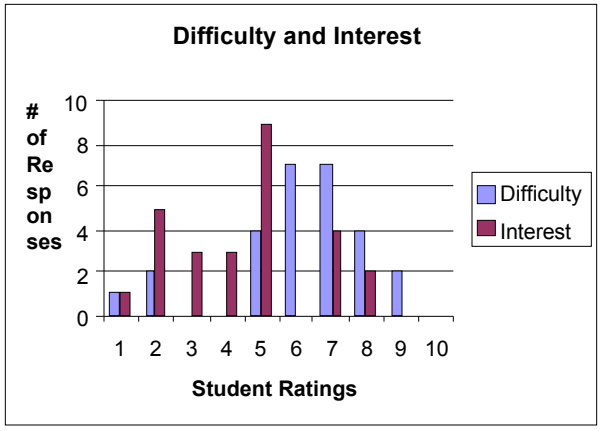

Figure 6. Student ratings of how difficult and how boring they found the class.

CONCLUSION

The conclusions of this work are somewhat simplistic. Generally speaking, students in an introductory class find even the basic concepts of statistics difficult and boring. The reason that they find it difficult appears to be a somewhat lacking mathematical preparation from high school. This has serious implications not only for the introductory classes, but also for planning the entire engineering curriculum. A second conclusion is that most students find the topic of statistics to be boring. While this fact will come as a surprise to no one, it does bear some discussion. Trying to introduce a concept that will definitely bore the students at the freshmen level runs contrary to the retention goals of first-year classes. One purpose of such classes is to build enthusiasm for their choice of major. On the other hand, two thirds of the students surveyed stated that they had no prior exposure to the topic. All respondents reported that they came away from the class with an appreciation of how and why engineers use statistics. This presents a conundrum. One must decide how to balance the retention aspect of selling engineering as an interesting major with the need for engineers to know and understand the basic concepts of statistics.

REFERENCES

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2. Moore, David, "Statistics: Decisions Through Data", videotapes, Video Applications Library, COMAP, Inc., Lexington MA., 1992.